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ABSTRACT

The Apple Classrooms of Tomorrow (ACOT) research project provides classroom sites with equipment, ongoing support, and training, enabling educators to discover the potential of networked learning environments. ACOT networks link together technology from Apple IIe computers and Image Writer printers, to Macintosh II systems, synthesizers, laserdisc players, scanners, and LaserWriter printers. Curriculums include subjects from reading, writing, and arithmetic to trigonometry, and networked software ranges from drill and practice to word processing and curriculum management tools. Teaching approaches that utilize the network span from directing students to work through electronic workbooks, to coaching them as they create entire curriculum units. Three kinds of network-supported learning environments can be utilized: self-paced, project-based, and knowledge-building. The first two reflect the current activity of ACOT classrooms, while the third predicts future ACOT activities. Two current research and development projects are described which demonstrate the use and value of electronic networks for building knowledge in a collaborative environment. (GL)

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Perspectives

ACOT Classroom Networks: Today and Tomorrow

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ACOT Report # 5
1989

Apple Classrooms of Tomorrow
Advanced Technology Group
Apple Computer, Inc.

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Apple Classrooms of Tomorrow℠ (ACOT℠) is a research project that explores learning when children and teachers have immediate access to interactive technologies. To pursue this research focus, ACOT establishes technology-rich classroom sites and encourages teachers to develop new curriculums and methods of instruction that take advantage of the technology. Within these environments, university-based researchers examine the long-term effects of the technology on teaching and learning. The project also supports R&D efforts that apply current learning theories in the development of curriculums, tools, and environments that can be integrated into ACOT and other classrooms.

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ACOT Classroom Networks: Today and Tomorrow

ACOT classroom networks currently support self- paced and project-based learning; however, the sites are moving toward using networks to promote knowledge construction in a collaborative environment.

Networked classrooms today probably look something like Alexander Bell's workspace must have looked back when he was exploring communication through cables. The observer sees a mass of equipment, wires, invisible power, and unpredictable outcomes. The entusiast, however, encounters an electronic adventureland, partially controlled and partially unsettled, with much promise for discovery. Mr. Bell's telephone system evolved as individuals used it and pushed its potential in new directions. The same process is now underway in networked classrooms as educators connect their computers and explore the new territory.

The Apple Classrooms of Tomorrow research project provides classroom sites with equipment, ongoing support, and training to find out what's possible with networked learning environments. As a result, teachers and students from primary through high school levels are in various stages of discovery. ACOT networks link together technology from Apple®IIe computers and ImageWriter® printers, to Macintosh®II systems, synthesizers, laserdisc players, scanners, and LaserWriter® printers. Curriculums include the 3-R's to trigonometry, and networked software ranges from drill & practice to word processing and curriculum management tools. Teaching approaches that utilize the network span from directing students to work through electronic workbooks, to coaching them as they create entire curriculum units.

The scenes that follow represent three kinds of network-supported learning environments: self paced, project based, and knowledge building. The first two reflect ACOT classrooms in action today. The third takes a peek at ACOT classrooms as they may be tomorrow. It's not a dreamer's vision, but a realistic picture that ACOT teachers, students, and network experts are in the process of building today. The back page supports the vision by presenting two R&D projects that currently demonstrate the use and value of electronic networks for building knowledge in a collaborative environment.

"A systemized approach to learning basic skills (such as the structured curriculum available on this network) has some definite value. It offers self-paced learning, which is beneficial to both faster and slower students. It provides teachers with a framework for teaching basic skills and insures them that individual students won't 'fall through the cracks.' Learning and practicing basic skills on a computer also motivates many students who have not been motivated by other modalities."
—Suzan Sollie, former ACOT coordinator

ACOT Today

Thirty fifth graders funnel through the door into the ACOT classroom, balancing books, floppy disks, papers, and various constructions-in-progress. Within a few minutes they're settled around long wooden worktables, built to accommodate three students on each side and roomy enough for pencils and paper as well as their Apple II computers. Built-in cubbies for storage and raised shelves for monitors make efficient use of minimal classroom space.

After various routines—collecting homework, reviewing long-term assignments, sharing personal news, and so forth—the day's curriculum activities begin. The teacher calls up six students for a lesson in fractions. She asks a dozen others to continue working through skill-building lessons on their computers, and the rest may begin writing their state reports. In a moment, multiple computer screens flash rainbow colors and students become absorbed in the assigned tasks.

One of the students who was asked to work on math lessons signs on the network by typing his name. He selects the appropriate lesson set from the menu, and soon his computer screen displays a lesson on decimal points—the very lesson he left unfinished last time. His neighbor's screen displays practice exercises on fractions that follow the group lesson she had with the teacher yesterday. The child next to her is playing the fractions game that concludes the unit.

These three students, side-by-side, work fairly independently on their lessons. The software enables slower learners to progress cautiously with lots of practice and reinforcement. The quicker learners can work faster, sometimes skipping over practice exercises when they demonstrate competency in the pre-test. (There is often a discrepancy between students of up to 20 lessons within just a few class periods.) The network's curriculum management system keeps track of students' work and records their scores on incremental pre- and post-tests.

Frequently, students help one another when they get stuck on a problem or when they feel like being neighborly, as they often do. The teacher encourages interactions that are instructive and supportive.

At a nearby table, two other students are working on their state reports. They chose word processing from the network menu and since both have finished their outlines and done the research, they are beginning to draft their reports. When they're done, they will save their work on floppy disks.

Network Facilities

This classroom network links 25 Apple II computers and three ImageWriter printers. The connecting cables, file server, 74-megabyte hard disk, and system software from Control Data Corporation provide the structure for the network. Over this foundation, management software from Computer Networking Service organizes the software used by teachers and students and displays it in a menu format.

Teachers have one section of the network available for storing assignments, tests, and other materials they have prepared for learners to download from the network. Students are able to access a variety of software on the network, but are unable to save or share their own work on the network. Students' work must be stored on floppy disks.

"The problem with a skill-based approach to learning is that some students get the idea that they are 'done' when they master those skills. I would rather provide a series of projects that require students to apply those skills at varying levels. A balance between projects and skill-building activities is probably the best solution for most elementary students."
—David Kittleson, ACOT coordinator

"The network is most effectively used as a means for sharing information. Publication of student work in any subject area is an extremely important incentive for high quality thinking and production. The network provides such opportunities for instant publication and sharing of student work.

The network also saves time and effort. It reduces the number of trips to the copy machine and cuts down on the amount of paper handling. Instead of making 30 copies of a handout, teachers and students can simply put it on the network."

—Sheila Cantlebary and Richard Tracy, ACOT teachers

ACOT Today

High school students in this ACOT classroom are intently listening to their social studies teacher talk about the Middle Ages, so the clackety-clacking of keyboards at their fingertips startles the first-time visitor. These tenth graders are taking notes on their Macintosh computers because they can type faster than they can write by hand.

Following the lecture, the teacher asks them to download a homework assignment he prepared and stored on the network. Students save their class notes and the assignment on floppy disks so they can refer to them later on their home computers.

When the whole-class activities are finished, students gather in small groups to work on curriculum projects. A couple of students are creating a HyperCard® stack with illustrations of Medieval castles and weaponry that they will use in a class presentation. When it's finished, the group will share the stack with everyone on the network. (This network is set up so that students can save and share their work on the network.) Another group of students is developing a slide show of scanned Medieval art masterpieces that they will also share on the network. Four others are

doing research for a report on the Crusades. They keyboard their notes into a network database so that everyone in the group can access them. Later they will organize the notes according to their outline, transfer them to a word processing program, and share drafts of the report on the network. Several other students are reading literature of the Middle Ages and reporting to the class through individual projects, such as fictional diaries that reflect the characters and the times, and animated HyperCard stacks that relate the plot and major ideas presented in the literature.

Recently, the social studies and English team teachers placed the "The Rules for Courtly Love" on the network. After discussing them, they asked students to write their reactions for homework and suggest some current "rules for love." The next day class discussion was particularly lively as students read one anothers' comments on their computer screens and debated with the other authors.

The network system is designed to enable teachers and students to conveniently access networkable software programs as well as a wide range of teacher- and student-prepared projects that are intended to be shared. Students can easily download lessons, assignments, tests, and gradebooks prepared for them by their teachers. Alternatively, teachers can store test scores, curriculum materials, notes, and other private files on sections of the network that are not accessible by students.

"Next year we plan to add a 'drop slot' capability to the network. This will permit students to 'pass in' homework on the network and enable teachers to access a collection of files more easily than having to open every student's disk file individually."

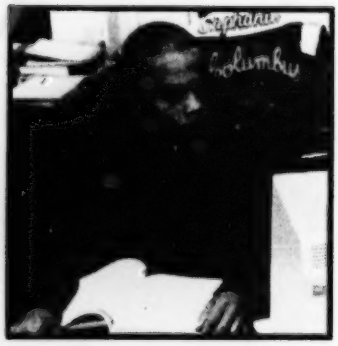
"Eventually we hope to have much greater sharing capabilities on the network, such as a database that is powerful enough to manage students' and teachers' research notes accumulated over time, and an inter-network mail system that's as easy to use as AppleLink® (telecommunications system)."
—Bob Howard, ACOT teacher and building coordinator

Network Facilities

This networked classroom contains two separate networks. Each links 16 Macintosh computers, four ImageWriter printers, and one LaserWriter. The file servers are Macintosh II systems with 80-Megabyte internal and 40-Megabyte external storage capacities. Since two networks are required to get all 30 students on a network, the site is currently connecting two networks with an Ethernet bridge. Using the Ethernet card and cables and Liaison software, two networks can be bridged together so that they work as one.

On top of the system software, MacJANET management software enables the network administrator to assign different levels of access and appropriate amounts of storage for each area of the network. Software tools, teacher-prepared lessons, student files, and areas for sharing are accessible by clicking on disk icons, just as one does on the standard Macintosh desktop.

"An ideal network system would integrate curriculum lessons and general tools such as word processing. It would be smart enough to detect specific problems and signal that the student needs instruction in these areas. The student could then work through skills-building lessons in those areas, or the teacher could pull groups of students with similar problems and provide instruction."
—David Kittleson



Knowledge – Building.....

ACOT Tomorrow

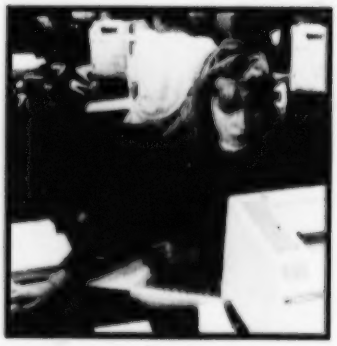
A bell rings to signal the beginning of first period, but half the seventh graders are already at their computers reading and sending morning messages over the inter-network mail system. Teachers often send students personal messages after reviewing assigments in the evening, and students use the mail system to schedule project meetings as well as share research notes and rough drafts. Of course, the convenience and privacy of electronic mail also invites personal communication among students. Teachers permit this activity before and after school, believing that the writing practice will benefit students' keyboarding and communication skills.

First period extends through most of the morning in this ACOT classroom as students and teachers need large blocks of time to work on projects that span several subject areas. Teachers with special expertise in language arts, social studies, and visual arts work with students during the morning block. In the afternoon, other teachers contribute their expertise in math, science, and music. Student projects range from creating a multimedia database that transforms the seventh grade history curriculum into a tour of the 19th century, to preparing and presenting a proposal to the city council on how to improve the local environment.

The student group that's building a history curriculum begins by developing an outline for the history course and doing expansive research in the outlined areas. Each student carefully researches one of the topics and writes notes on electronic index cards that are stored on a network database designed for this project and available to all group members.[1] They use the network to access the school library's card catalog and the CD-ROM encyclopedia. Students can also link to various online resources through the network modem. As the curriculum database grows, students begin designing a SuperCard stack that can present the information as a meaningful experience for other learners.

The group decides to include scanned images from books they have read to show the typical fashions, architecture, artwork, and other things specific to 19th century America. The students also want to include recorded music of the period and excerpts from famous speeches. Finally, they want to add motion picture footage from films that accurately represent the period.

.....Learning Environments



Designing a SuperCard-based multimedia curriculum for both independent learning and class presentions requires on-going guidance from the teachers. For example, students want to design the curriculum so that learners can pursue topics in any order they wish—social customs of the early 1800's, politics of the 1890's, post Civil-War economics, and so forth. Teachers suggest that a chronological approach would be helpful so that learners can grasp a sense of historical development. Group members respond that they can provide the historical context in their class presentation and that perhaps adding a graphic timeline to each text screen would provide enough structure. The group later decides to include an "historical sequence" option that the learner can select for a chronological presentation of topics.

Throughout the development of this multimedia project, students share their work by saving it in the group's network folder. While the project is in progress, only group members can access this folder. After making a presentation and introducing classmates to the interactive curriuclum, everyone on the network is given access to it. In fact, classmates begin using it right away to study the material they're expected to cover for seventh grade history. Many of them do even more than that. They become so involved in particular topics that they do further research and add new information to the curriculum. The result, over time, is a complete (but never completed) history course that is produced, developed, and owned by the students. Pedagogically, the result is an approach to learning that allows students to build knowledge, based upon their own experiences, research, and understandings. This approach is supported by a network system that provides the means to share information, access information from multiple resources, link to a variety of storage devices, and communicate personally with other indiviudals.

"My ideal network would also enable students to access multiple media—the library card catalog, CD ROM and on-line resources, interactive video, scanners, and so forth. With a smarter operating system and a larger capacity for storage, students could save and share their work on the network and they could use it as a means for accessing a whole range of multimedia resources."
—Suzan Sollie

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[1] A special editing feature on the network provides feedback on students' writing. The network editor highlights problems such as spelling errors, run-on sentences, and lack of subject-verb agreement, providing teachers with diagonistic information on students' basic writing skills. With this information, the teacher can provide instruction and/or assign the appropriate skill-building lessons available on the network. The network also provides a similar program for basic math skills.

Current Research and Development on Networks

"Earth Lab stimulates communication between students and teachers in all subject areas. It enables students to access new sources of information and reach larger and more diverse audiences. Sharing students' work on the network also promotes more effective peer communication and collaboration."
—Denis Newman, Earth Lab project director

"A network environment that enables individuals from different locations to plan projects, share information, and create multimedia documents can promote effective collaboration in both school and business."
—R&D project manager, Apple Computer

Current R&D projects at BBN Systems and Technologies and at Apple Computer are examining how individuals work and learn in networked environments. Both projects involve the experimental development of electronic networks that support collaborative work and both involve research on network use.

Earth Lab: A Network for Young Scientists is designed by BBN researchers to promote student collaboration in scientific investigation. Using a computer network that links classrooms within a school and distant locations via telecommunications, students can engage in real-world scientific inquiry. In the sixth-grade research site, for instance, students collect daily weather data and enter it in a shared database. Weeks later they analyze the data and develop principles for predicting weather. To test their theories, they access online weather maps of the approaching weather conditions in outlying areas. Students use the local electronic mail system to pose questions and collect answers offered by teachers and schoolmates. They use the long-distance mail system to share their data and findings with a wider audience.

An experimental network designed by researchers in the Advanced Technology Group at Apple Computer, supports the process of planning and implementing group projects. For example, a project leader can use the network database of individuals' skills and interests to select a balanced team. Network "conference rooms" enable teammates at different locations to attend meetings electronically. During the meetings, they can see one another on their computer screens (via video camera), hear each other (via microphone or telephone), share text and graphics (via computer files), and watch video clips (via videotape or laserdisc player). Teammates gather information for the project by accessing distant resources and they create and revise report drafts using multimedia composing tools. Group members cut and paste text, graphics, audio, and video segments from their collective "notes" and develop them into a multimedia presentation. All phases of the project can be completed collaboratively within this network environment.